DIVISION OF ENTOMOLOGY

CIRCULAR NO. 3

REPORT OF WORK

OF THE

EXPERIMENT STATION

OF THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

The Sugar Cane Borer

(SPHENOPHORUS OBSCURUS)

IN THE

HAWAIIAN ISLANDS

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HONOLULU, H. T.

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LETTER OF TRANSMITTAL

Honolulu, T. H., November 4, 1907.

To the Experiment Station Committee of the
Hawaiian Sugar Planters' Association,
Honolulu, T. H.

Gentlemen:—Herewith I submit for publication Circular 3, of the Division of Entomology, entitled "The Sugar-Cane Borer (*Sphenophorus obscurus*) in the Hawaiian Islands."

This has been prepared by Mr. F. W. Terry, and sets forth what is known in these islands of the Cane-borer.

Yours respectfully.

G. W. KIRKALDY,
Acting Director, Division of Entomology.

GLOSSARY OF TECHNICAL TERMS USED IN THIS CIRCULAR.

Chitin: The horn-like material forming the hard portions of insects.

Cocoon: The protecting case for the *pupa,* also called *pupa-case.*

Elytra: The chitinous wing-cases of beetles, which in repose cover the true wings (sing.=*elytron*).

Frass: The solid excrement of insects.

Labium: The lower lip, often forming the floor of the mouth.

Labial palpi: A pair of tactile jointed organs attached to the side of the *labium* (sing.=*palpus*).

Larva: The immature and usually 2nd stage of an insect's life-cycle, often existing as a *grub, maggot* or *caterpillar.*

Mandibles: The 1st pair of true *jaws* (in a mandibulate insect).

Mandibulate: Possessing mandibles, (opposed to *suctorial*).

Maxillae: The 2nd pair of *jaws* in a mandibulate insect, often reduced and not *masticatory.*

Maxillary palpi: A pair of tactile organs, borne on the *maxillae.*

Ovipositor: The tubular or valved organ by which the eggs are transferred to some foreign body.

Pubescence: Very microscopic short hairs.

Pupa: The quiescent or 3rd stage of those insects having marked change of form.

Prothorax: The swollen segment between the head and abdomen and bearing the first pair of legs.

Pygidium: The upper part of the last segment of the abdomen, usually exposed beyond the *elytra*.

Rostrum: The beak or snout-like prolongation of the front part of the head.

Spiracles: Paired slit-like openings on the body segments, through which the air enters the *tracheae*.

Tarsal: Pertaining to *tarsi* or segments of the feet.

Tibia: That portion of the leg bearing the *tarsus* or foot at its extremity.

Tracheae: Fine air-tubes composed of spirally-arranged threads of *chitin*.

THE SUGAR CANE BORER

GENERAL REMARKS ON THE CANE BORER AND ITS ALLIES.

The Cane borer of these islands (*Sphenophorus obscurus Boisd*) is a member of that large family of beetles, the "weevils" or *Rhynchophora*, readily distinguished from the other families of that order by their characteristic curved beak or rostrum, formed by the front portion of the head being much produced, and bearing at its apex a pair of strong though minute mandibles. This peculiarity has popularized them under the name of "bill-bugs," or "snout beetles," the former appellation appearing to be more especially applied to that division to which our cane borer belongs i. e. *Calandridae*.

Economically the weevils are an extremely important group, embracing such well-known pests as "Cotton boll-weevil" (*Anthonomus grandis*); Various "pine weevils" (*Pissodes*); "Plum Curculio" (*Conotrachelus*); "Clover weevils (*Phytonomus*); "Rice weevil" (*Calandra oryzae*); "Corn bill bugs" (several species of *Sphenophorus*); Fuller's Rose beetle" (*Aramigus fulleri*) a well known pest in California, better known on these islands as the "Olinda bug;" and hosts of others. In warmer climes we find such species as the "Mango Weevil" (*Cryptorhynchus mangiferae*) which has unfortunately established itself on these islands within the present decade; "Palm weevil" (*Rhynchophorus palmarum*) widely distributed throughout the Orient, and attacking the coconut and other palms; In the West Indies we find the "weevil borer" (*Sphenophorus sericeus*), closely allied to our own borer, and a pest on sugar cane also.

The popular name "borer" although restricted to only one insect on these islands, is also applied to the larvae of several moths in other sugar-cane countries, e. g. the well-known "moth-borer."

(Diatraea saccharalis) a cane and maize pest in India, West Indies, Louisiana, New Mexico etc. The "stengel boorder" (*Diatraea striatalis*) and "gele boorder" (*Chilo infuscatellus*) in Java.

The "butterfly borer "or" larger moth borer" (*Castnia licus*) in British Guiana, West Indies etc. and various small beetles (*Xyleborus perforans*) and others, collectively called from the character of their larval tunnels "shot-hole borers." The closely allied *Sphenophori* of the West Indies, *S. sericeus* and *S. sacchari* appear to have similar habits and life histories to our own *S. obscurus;* and in addition to the popular name of "weevil borer" they are frequently referred to as "lady-bird borer," a most confusing and unfortunate misnomer.

Our knowledge of the distribution of the cane borer is far from complete, and its original habitat still remains a mystery. Besides its general distribution over these islands it is recorded from Queensland, New Guinea, New Ireland, Fiji, and Tahiti, and probably will be found on several other islands of the Pacific. Although *sugar-cane* forms its main food-supply, both *banana plants* and *palms* are attacked. A striking instance, from personal experience, being that of a fine young *"loulu"* palm (*Pritchardia*), being so hopelessly infested that it had to be cut down and destroyed. I quote also Mr. Koebele's experience.

* "The principal food plant of the beetle as far as known is the *sugar-cane* on the Hawaiian Islands, Fiji, New Guinea, and lately in Queensland, besides it is found on a great variety of succulent plants, many species of palms are affected and even destroyed, such as the *cocoanut*, the *royal* and *cabbage palms*, the two native species of *Pritchardia* have been seen destroyed by same, and several others. The *banana plant* is often seriously affected, not so much on these islands as in Fiji. The *papaia plant* must be included, at least, in a decomposing condition, in which state it appears to live upon many plants. We have seen a trunk of the common *Caryota urens*, cut up in lengths of about 3 feet and used as flower stands in a garden, completely riddled with holes made by the beetle, and they were still present within two years or more after the tree had been cut. Any tender or decomposing part of *palms* seems to answer them as food."

* "Brother Newell of Hilo writes me lately that large numbers of cane-borer beetles were attracted upon shafts of leaves of the *royal palm* a few days after falling from the trees, and they

* The Planters' Monthly, Vol. XIX. p. 519.

would continue to come for weeks after. As previously stated, if the interior part of sugar cane cannot be reached, the beetle will live for weeks behind the sheaths of leaves while yet tender, and here feed upon the epidermis of same."

This certainly suggests that originally it was a palm or possibly wild banana pest, sugar-cane being a later addition to its diet.

Owing to their nocturnal and secretive habits, the adults may often be quite abundant without their presence being detected. During the day they usually remain hidden beneath the leaf-sheaths or within their old borings, but towards dusk they become quite active and readily take to flight. Mr. Koebele says.

* "Often the Sphenophorus beetle has been seen flying during the hottest part of the day, around mills in operation on these Islands, most numerously they were observed on Kauai at sunset until dusk, coming from a recently burned field across the road and settling down upon the young plants. Its wings are well developed and its flight is very rapid, so much so as to be with difficulty followed with the eyes."

LIFE HISTORY.

THE EGG.

(Pl. I, figs. 1-2.)

The egg is ivory-white and enclosed in a thin tough membrane, narrowly oval and slightly curved, varying somewhat in form and dimensions, e. g. from 1.35x.55 mm to 1.75x.6 mm (averaging about 1/17x1/45 inch. (Pl. I, fig. 2 *c*).

It is placed singly, usually about ⅛ inch or less beneath the cane-rind, within a small cavity, (Pl. I, fig. 2 *a* and *b*) previously eaten out by the female borer. Less frequently as previously mentioned, they may be found in the leaf-sheaths or in the walls of the old disused borings.

THE LARVA.

(Pl. I, figs. 3-6 and Pl. II, figs. 2-3.)

The incubation period is usually constant, the larva hatching about the 6th day, the egg membrane splits longitudinally and the young larva upon emergence is of a pale translucent ivory whitness, with the exception of the slightly darker mandibles.

* The Planters' Monthly, Vol. XIX, pp. 519-20.

At this stage the larva is not larger than the egg, usually about 1.40x.5 mm (1/18x1/50 inch). The chitin of the head and mandibles soon darkens and hardens, becoming after a few hours yellow, and later on reddish-orange as the larva approaches full growth. Although the adult larva is so familiar to the majority of planters, the following brief description may be of interest. The adult larva (Pl. I, figs. 4-6) including the head averages 15 mm x 8 mm, (about 3/5x1/3 inch), and is a footless, deeply-wrinkled, swollen-looking grub, pale yellowish-grey, the food material often showing through the translucent skin of the distended abdomen. Just behind the head, the chitinous layer of the upper part of the 1st segment is thickened, forming a yellowish narrow plate, the *cervical shield*, (Pl. I, fig. 5 *b*).

The head is oval and bright reddish-orange, and the simple eyes are so extremely minute that they are difficult to see, and must be practically functionless; both head and body are sparsely covered with stiff hairs, which no doubt serve as tactile organs whilst the insect travels through its tunnels. The blackish mandibles are very strongly chitinized and well-adapted for chewing the fibrous stem-tissue. (Pl. II, figs. 2-3). As in other insects, (larval and adult), the respiration is carried on by means of tracheae; these tubes a very numerous and ramify (like the roots of a plant) throughout the entire body, becoming extremely fine at their extremities; this tracheal system communicates with the external air, through a series of slit-like openings or spiracles; these spiracles, (Pl. I, fig. 5 *a*) are arranged in pairs, usually one pair to each body segment.

The larval period varies greatly as the previous experiments of Mr. Koebele and recently my own prove. Mr. Koebele says * "It is difficult to ascertain the number of moults the larva goes through, as far as can be made out it is six, becoming full grown in about seven weeks, more or less, according to condition of food plant;"

My own experiments during Aug.-Nov. 1906, gave an average of 81 days. This variation is largely dependent upon the condition of the cane and also temperature, a soft cane and high thermal average naturally inducing more rapid development. The attempt of both Mr. Koebele and myself have failed to determine definitely the number of larval moults, the feeding habits making this practically impossible.

* The Planters' Monthly, Vol. XIX, p. 520.

THE PUPA.

(Pl. I, fig. 7.)

The 3rd marked stage in the life-history of our pest is that of the *pupa*. The larva previous to undergoing its transformation ceases to feed, and constructs from the cane-fibre the familiar *cocoon*, within which the metamorphosis takes place. This metamorphosis is so complete that not a single organ, internal or external remains the same, all the external organs of the future beetle are clearly defined, although ensheathed in a translucent covering of chitin. The newly formed pupa is of a pale creamy white, but gradually the markings of the future beetle develop, at first these are pale brown but rapidly darken. The future elytra are at this stage quite soft and folded around the sides of the pupa (Pl. I, fig. 7 *c*); the sheaths containing the wings can be seen projecting just beyond these, (Pl. I, fig. 7 *d*). The pupal period is somewhat variable, Mr. Koebele says * "the transformation of the pupa takes two weeks, and another couple of weeks will elapse before the insect issues." My own experiments during Aug. 1906, gave a range of 8-9 days for the pupal period, and 4-7 days before the beetle had attained its normal colouration and hardness.

THE ADULT.

(Pl. I, fig. 9-13 and Pl. II, fig. 1-1 f.)

So familiar an object is the adult beetle on the plantations, that a detailed description is unnecessary. The general colouring is a dull light brown, the prothorax being usually brighter, with a blackish central band. The elytra are darker, with one central pair of blackish patches and one lateral; The whole often covered with a greyish pubescence. Fine but distinct impressed lines run longitudinally along each elytron. The very conspicuous curved rostrum, readily distinguishes the borer from any other beetle occurring in the cane-fields. The difference of form in this organ also serves to easily identify the sexes, that of the male being much thicker and less curved, the under surface having a double row of tubercles (Pl. I, fig. 11); the finer and smoother structure of the female rostrum (Pl. I, fig. 10) being better adapted for preparing the egg-cavity. (Pl. I, fig. 12) shows the apex of the rostrum with the partly-opened sharp-

toothed mandibles, these teeth dove-tail neatly together when closed. (Pl. I, fig. 13) is an underneath view of the rostrum, with the mandibles widely distended. [This lateral position of the mandibles is as characteristic of the great group *Arthropoda,* (of which the *Insecta* form a division) as are the vertical jaws of the *Vertebrata*].

The maxillary palpi (Pl. I, figs. 12-13 *b*). function as guiding organs for the food-material and assist in mastication. One other sexual difference readily distinguished is the blunter form of the male pygidium (Pl. II, fig. 1 *f*), when compared with that of the female (Pl. II, fig. I *e*).

A portion of this segment is covered by the elytra (Pl. II, fig. 1 *c*).

An adult female (Pl. II, fig. 1). is shown with the right wing extended for flight, each wing is strengthened by thickened chitinous veins, and when not in use is folded up at its middle (Pl. II, fig. 1 *b*) and lies over the back, protected by the elytron (Pl. II, fig. 1 *a*). Each leg is furnished with a strong curved spine at the extremity of the tibia, enabling the insect to grip very securely and resist any ordinary attempts to dislodge it, as well. as to dig into the cane tissue. The foot is segmented and bears in addition to a pair of strong claws, a large pad, the 3rd tarsal segment (Pl. II, fig. 1 *d*) the undersurface of which is densely clothed with adhesive hairs, by which means the beetle can walk with perfect facility up the smoothest surface.

METHOD OF DEPREDATION.

As repeated experience has shown, the softer cane varieties, or those of rank growth in moist fields, suffer most severely from attack, although from personal experience, hard varieties such as *Yellow Caledonia* may be fully as badly infested as adjoining *Lahaina,* but owing to the harder fibre and rind, this cane does not break down so easily and the resulting injury is less.

The female having entered beneath a leaf-sheath which has commenced to loosen from the stem, usually selects for oviposition that internodal area above the eye, the sheath acting as a fulcrum for her body, thus facilitating the preparation of a cavity for the egg, the sharp-toothed mandibles (Pl. I, figs. 12-13) coming into requisition for this act. Having pierced through the cane-rind, a short curved passage following the curve of the

rostrum, is made into the tissue beneath, to a depth of about ⅛ inch. Mr. Koebele thus describes the process. *"When the egg is laid in the cane from the outside, this is done from under the sheath, which the beetle can brace against, with the prominent saw-like movable teeth laterally, she first begins to eat the hole until softer ground is struck, so to speak, when she will force the work, moving the head up and down as well as sideways, until the whole length of the beak is buried. Upon soft parts on split cane this operation takes from 1½ to 2 minutes; no doubt much longer in boring through the hard epidermis, probably hours."

The beetle then completely reverses her position, brings the extremity of the abdomen to the egg-cavity, and places a single egg therein by the aid of the ovipositor. This egg always being placed with it long axis parallel to the cane-fibre.

The time occupied in ovipositing is evidently very variable, since Mr. Koebele says *"4 to 6 minutes," whilst from my own observations it is much less, on one occasion being only ½ minute.

This act may be repeated within a relatively small area of the internode, but usually 2 or 3 egg-insertions are the maximum for one internode. † Mr. Harry Baldwin recently informed me that he had bred larvae from leaf-sheaths, a fact unknown to me previously. I have since had the same experience, but believe this method of oviposition to be unusual.

The larva very shortly after hatching proceeds to work its way into the stem tissue, frequently taking a downward course, but usually it continues in an upward direction, frequently traversing and enlarging its old course with its increasing appetite and bulk. The diagrams (Pl. II, figs. 5-9) illustrate the feeding methods from actual experiments; newly hatched larvae were inserted in isolated growing cane; the adult beetle emerging at *b; c*, represents the cocoon; (*the arrow indicates the course taken by the larva*). Upon looking up my breeding notes I find that one larva remained below the point of insertion during its entire feeding period, finally emerging opposite the insertion hole. Although large quantities of stem tissue are digested and excreted as frass, immense quantities are simply masticated to express the juice, both forms of waste material serving to block up the lar-

* The Planters' Monthly, Vol. XIX, p. 520.

† Since preparing this circular, I find that this habit of ovipositing in the leaf-sheaths, is commoner than I had previously supposed.

val passage, (Pl. II, fig. 4 *f*). As an illustration of the voracity of the larva, Mr. Koebele says—*"A half-grown specimen traversed a piece of cane six inches in length, from one end to the other, in three days."

Frequently the larva approaches too closely to the rind, breaking through and producing rupture holes (Pl. II, fig. 4 *b*) of various sizes; these when very small are frequently mistaken for egg-insertion holes (Pl. II, fig. 4 *c*) or when larger, exit holes. Pl. II, fig. 4 *a*). The full-grown larva, preparatory to pupation, eats out its exit hole and constructs a strongly made cocoon composed of cane fibre, wound spirally and kneaded compactly together. (Pl. I, fig. 8 and Pl. II, fig. 4 *d*).

The following summarization of the life-cycle from Mr. Koebele's (*A*), and my own experiments (*B*), may be of interest, since it shows how variable the various stages may be:

	(A)	*(B)*
Preparation of the egg cavity:	"1½–2 minutes."	One female observed eating out hole occupied less than 1 minute.
Oviposition:	"4–6 minutes, much longer in hard rind."	½ minute in ordinary "Lahaina" cane.
Incubation period:	"6 days, from repeated observation."	5–7 days; (average 6 days from repeated observation.)
Larval period:	"About 7 weeks, according to condition of food."	76–91 days; (average about 81 days.)
Pupal period:	"2 weeks."	8–10 days; (average about 9 days.)
Adult remains in pupa-case before emerging:	"2 weeks."	About 10 days.
Period from egg to adult:	"About 3 months."	95–104 days; (average about 99 days.)
Duration of life of adult female borer:	"Probably 10-12 months half of which period she deposits eggs, probably 4–8 per diem."	Do not know

* The Planters' Monthly, Vol. XIX, p. 520.

METHODS OF PREVENTION.

Usually the earliest growth in which borer infestation manifests itself is that of 6-9 months cane, unless, as is frequently the case with a ratooned field, the stools themselves contain larvae. Numerous methods for checking the increase of the pest have been tried, the following being those most generally adopted.

. . . . . .

Collecting by Hand. . . . . This method although far from satisfactory is perhaps the most practical that has yet suggested itself. The practicability of its adoption on any plantation is naturally regulated by the labor conditions. Women and children are employed for this work, the latter proving themselves very adept at gathering the adult beetles. One objection to this method, often raised by the planters, is, that the collectors generally do considerable damage to the cane, by tearing down the leaf-sheaths in order to reach the insects. This to a certain extent is true, but greater care could probably be induced, if the method of payment was *per diem,* and not *per ounce* or *per hundred,* as is generally the case at present. One manager informs me that formerly they payed *per bottle,* but found this conducive to too hurried and careless stripping; payment was then changed to *per diem,* with satisfactory results. Even the most careless methods of gathering are preferable to none at all; for, assuming that an occasional stick does get broken, or practically destroyed by rough stripping, yet, *the capture of one female alone per stick,* (which is a low estimate for the average infested field) *will probably save dozens of others.*

Bait. . . . . As is well known the beetles are readily attracted to sour or fermenting sticks; this fact has been utilized on certain local plantations as well as elsewhere with satisfactory results. Mr. Koebele referring to his experience in Feb. 1899 at Lihue Plantation says *"4,545 beetles were brought to the office * * * and as Mr. C. Wolters informed me, these were collected by ten men and ten women, while stripping, on baits of split cane laid out for them at a cost of about $9.00." Again, he says *"Owing to the numerous ants which irritate but do not injure the hard beetles the bait-trap of split cane is not such a success as it proved at the Fiji Islands; yet large numbers of them can be collected by this plan which should by all means be adhered to."

* The Planters' Monthly, Vol. XVIII, p. 577.

* "It has been found that the cane pieces left in the field in a few weeks were completely filled with borings of young larvae, which cannot mature in the dry cane but invariably perish. For this fact alone the otherwise useless pieces of cane should be laid out."

The following was Mr. Koebele's experience in Fiji during 1892.

† "At the request of the Colonial Sugar Company we looked into the matter with a view of getting rid of the beetles the best way possible; all sorts of devices were employed and none worked better than pieces of split cane about 12 inches long, placed along the edges of the field and through the same at intervals of 12-18 feet, thus with seven little Indian girls, I collected over 16,000 beetles in some four hours, and the same little girls alone brought in the following noon over 26,000 beetles."

† "This method was kept up, and followed on the all plantations for the next three years, or until no more of the borers could be found. Tons of the same were brought in at the Nausori mill alone, and the expenses of collecting were practically nothing compared to the cost at Lihue, where such work has to be done by the day laborers. About four cents per pint of the insects was paid to the children. The result has been highly satisfactory, for, ever since the last five years, the cane borer has not been a pest in those Islands."

The above method is probably more satisfactory under the more humid conditions of those islands than here, where, the split cane dries very rapidly, to remedy this, the cane (after the morning's collecting) could be thrown into an irrigation ditch and removed towards evening for bait.

WEIGHT OF BORERS.

The adults appear to be usually reckoned at 300 per ounce, I find however that 310 *living borers per ounce* is more accurate. The beetles do not usually vary greatly in size, although occasionally starved specimens occur; the greatest range of weight observed between indivduals being .044-.117 grammes.

As will be seen from the following table of comparison, there is a considerable range of methods and rates of payment.

The following comparison of five selected plantations may be of interest.

* The Planters' Monthly, Vol. XVIII, 577.
† The Planters' Monthly, Vol. XIX, p. 522.

PLANTATION.	RATE OF PAYMENT.	NUMBER COLLECTED.	REMARKS.
A.	40c-50c *per diem* (As much as $9,000 *per annum* has been spent).	8,000-10,000 *per diem*.	When the cane becomes too big for collecting, the borered sticks are cut up, placed upon trash-piles and burned.
B.	25c-50c *per diem*, according to age and aptitude of collectors.	800-1,000 by each child *per diem*, (About 2 millions during 2 years).	Formerly this plantation paid *per bottle*, but found this method induced hurried work and consequent injury to cane.
C.	5c *per hundred*.	1,200-2,000 *per diem*.	Bags of seed-cane were kept damp in ditches till night. Women collected borers the following morning.
D.	5c-10c *per ounce*, (reckoned at 300 borers *per ounce*).	600 lbs. during one bad season. (i. e. about 2,880,000 borers).	
E.	25c *per ounce*, (reckoned at 300 borers *per ounce*).	Nearly 5 millions during a period of 5 years.	The collecting on this plantation has been very systematic, and the manager reports a diminution of the pest.

BURNING INFESTED STICKS.

The importance of gathering up and burning infested cane-sticks at the earliest opportunity after cutting, cannot be too strongly emphasized, and in order to make this effective, a second burning aided by kerosene or other inflammable material is essential. When the infestation has been severe, the stools should be dug up, added to the trash-pile and re-burned; since, as is well known, the ordinary burning of trash does not reach those larvae and adults in the stools, and only kills a certain amount in the sticks.

STRIPPING.

This much-disputed cultural process, apart from its agricultural aspect, becomes also involved in the borer question, and is of course dependent on the local conditions and discretion of the manager. Undoubtedly free access of light and air are uncongenial to borers, and since the parasitic control of the leaf-hopper is an established fact, the former danger (by thus exposing the soft sticks and creating fresh breeding areas for this latter pest) is now considerably minimized.

BORERS ENTERING THE SOIL TO REACH SEED-CANE.

The following experiments were made in order to ascertain whether the adults would enter the soil to reach seed-cane. Seed-cane was placed in suitable vessels at depths varying from ½ inch to 3 inches below the soil, some pieces of cane being also placed on the surface for food. Frequent examination was made and it was found that after a few days several borers had reached the "½ inch" cane, evidently to oviposit, as numerous larvae were found in this same cane later.

PREDOMINANCE OF MALES.

The males appear to predominate, but their ratio of excess would appear to vary according to the season.

Mr. Koebele says *"On February 8, 1899, 4,545 beetles were brought to the office at the Lihue plantation," "of these beetles 3,181 proved to be males and 1,364 were females."

This represents approximately 70% males and 30% females, or an excess of 40 males per hundred.

From my own examination of 3820 borers during Aug.-Oct. 1907 the following results were obtained, approximately 60% males and 40% females or an excess of 20 males per hundred.

* The Planters' Monthly, Vol. XVIII, p. 577.

RESISTANCE TO DROWNING.

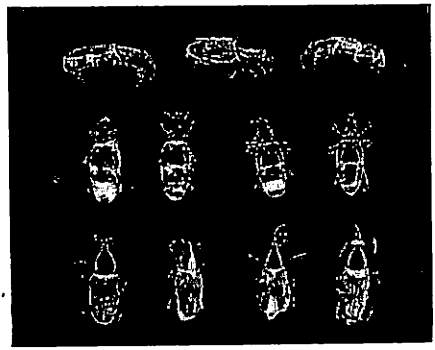
Both adults and larvae are extremely tenacious of life, and survive prolonged immersion in water. Larvae were found to survive after 27 hours; and adults after 24 hours of complete immersion. The majority in the various experiments being apparently none the worse for their experience.

FOOD OF THE ADULT.

The mature beetles appear to feed continuously. The females are probably more voracious than their mates, since they require more nutriment to nourish their developing eggs. The amount however eaten by the adults as compared with the larvae is negligible. Their favorite diet is decaying moist stalks, and the older and dying leaf-sheaths, these being attacked from their inner surfaces.

PARASITIC FUNGUS (*Penicillium*)

In conclusion, since the existence of a fungus parasitic upon the borer, has been known for some years by the entomologists and a few planters, it is advisable that attention should be called to it. If its effectiveness as a death-factor is as great as some would suppose, the period of its existence on these islands has certainly been sufficiently long, for it to have demonstrated its potency in this direction, more completely than our present knowledge can prove.



Adult borers killed by a parasitic fungus (*Penicillium* sp.), one week after inoculation.

The accompanying text-figure shows adult borers a week after innoculation. In its earlier stages this fungoid parasite shows

itself as a floury whitish mass between the segments of the body and legs. Later, as the plant matures and the spores ripen, these white areas become pale green, like an ordinary mould fungus. At present, its affinities to the Japanese-beetle fungus are undetermined.

PLATE I.

1. Eggs, (nat. size).
2. Eggs, (much enlarged).
   a, section of egg-passage with egg *c*;
   b, egg placed unusually near the rind;
3. Larvae, just hatched and older (nat.size).
4. Larva, adult (nat. size).
5. Larva, side view (enlarged).
   a, spiracles;
   b, cervical shield.
6. Larva, front view (enlarged).
7. Pupa, (enlarged).
   a, rostrum or "beak;"
   b, antenna;
   c, elytron or "wing-case;"
   d, wing folded up.
8. Pupa-case or "cocoon," (enlarged).
9. Fully matured male borer, (enlarged).
10. Head of female borer, (enlarged).
    a, rostrum;
    b, antenna;
    c, eye.
11. Head of male borer, (enlarged).
    a, rostrum;
12. Apical extremity of rostrum, (much enlarged).
    a, mandibles, showing the sharp-cutting teeth;
    b, maxillary palpi.
13. Extremity of rostrum, viewed from beneath (much enlarged).

PLATE II.

1 Mature female borer (enlarged).
   a, wing-case;
   b, wing, extended for flight.
   c, pygidium.
   d, adhesive pad of foot.

1*e*. Terminal segment of the abdomen (female beetle).
1*f*. Terminal segment of the abdomen (male beetle).
2. Head of adult larva, front view (much enlarged).
a, mandibles.
b, labial palpi "lip feelers."
c, maxillary palpi "maxillary feelers."
3. Mouth-parts of adult larva, viewed from beneath, (much enlarged), (*lettering as in* 2).
4. "Borered" cane stick (½ nat. size).
a, *"emergence"* holes made by the larva before pupation;
b, *"rupture"* holes, apparently accidental and made by the larva whilst feeding.
c, *"entrance"* holes, made by the female borer for the reception of her eggs;
d, cocoon;
e, larva;
f, *"frass"* or undigested cane fibre, passed by the larva.
5&6. Diagram A. sectional and external view:
a, insertion hole;
b, emergence hole;
c, cocoon (*the arrow-head indicates the course taken by the larva*).
7. Diagram B. (*lettering as in* 5&6).
8&9. Diagram C. external and sectional view: (*lettering as in* 5&6).

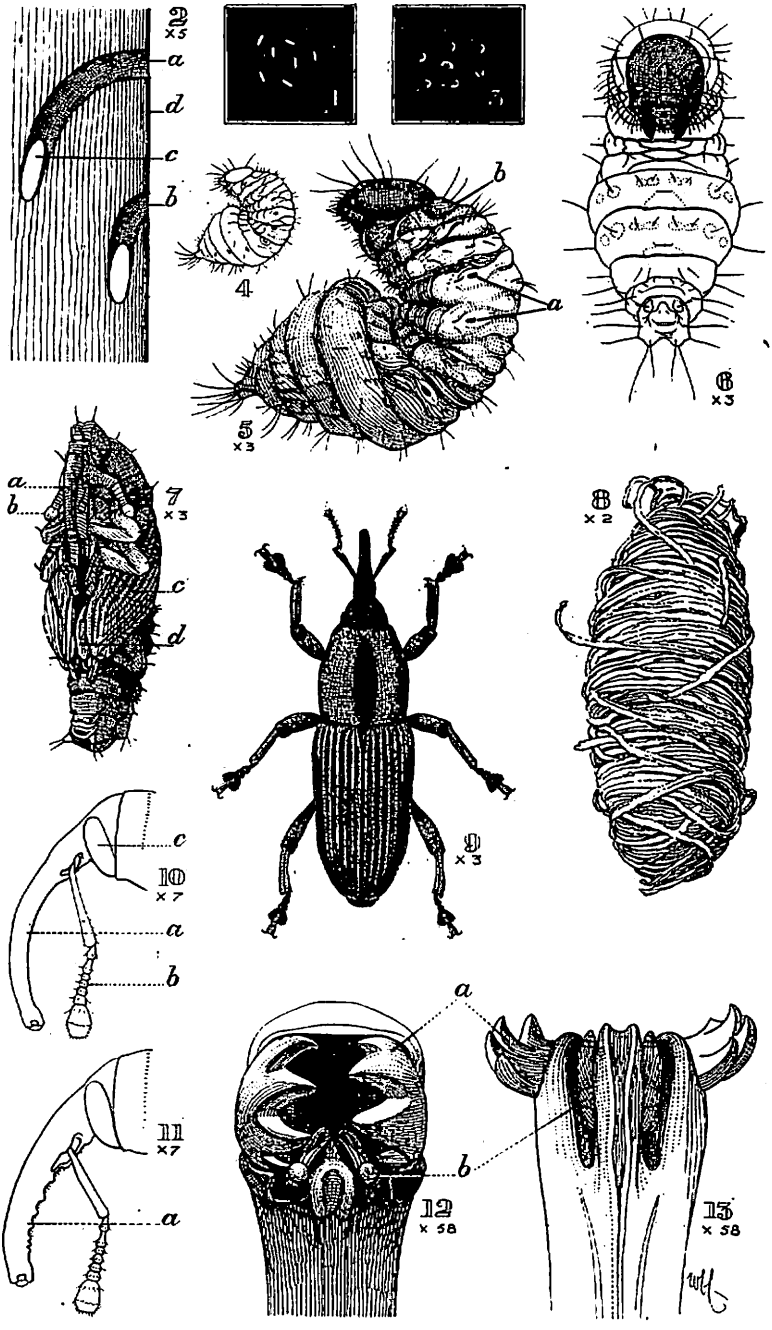


PLATE I.

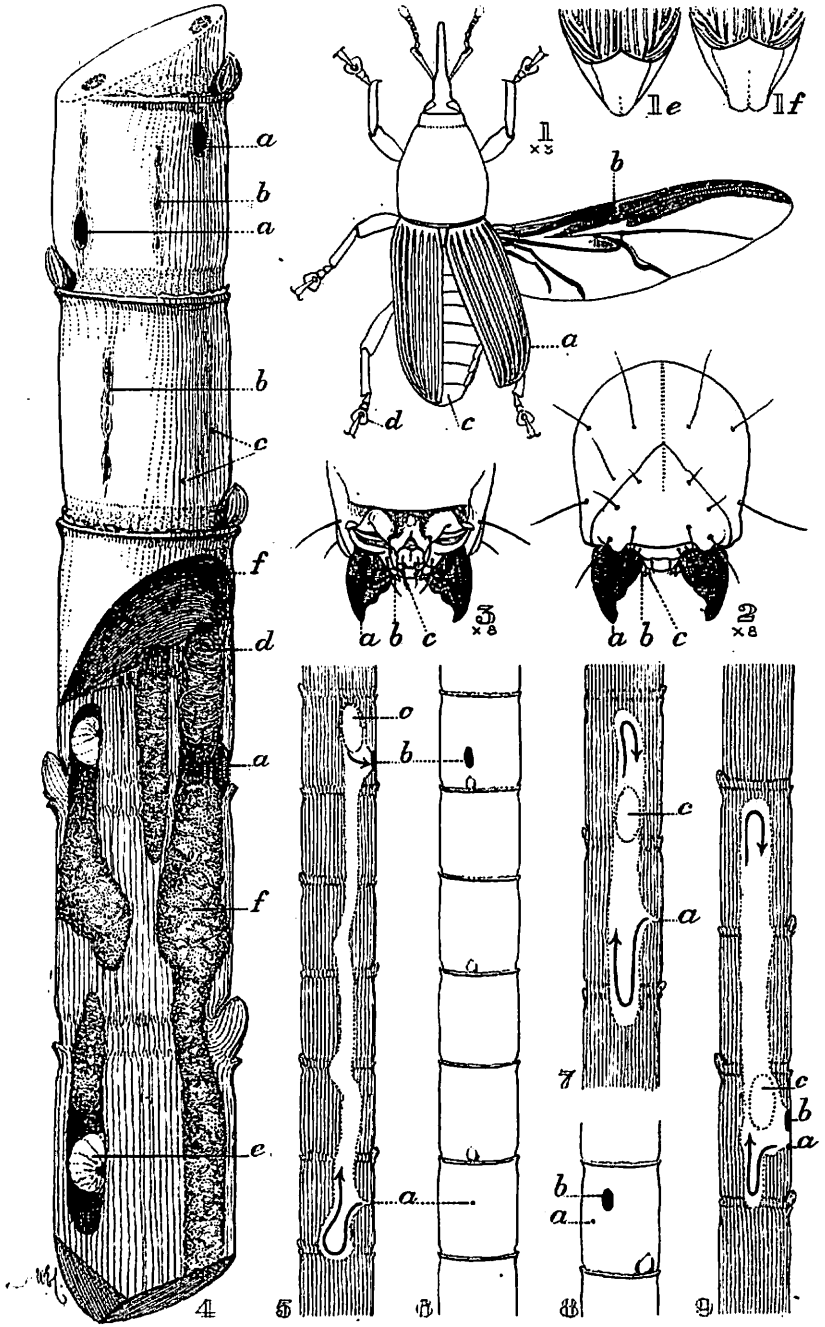


PLATE II.